INDUSTRIAL HYGIENE SUPPLEMENT, INDUSTRIAL MEDICINE

This Industrial Hygiene Section is published to promote sound thought upon and concerning industrial hygiene. To that end it will contain articles, discussions, news items, reports, digests, and other presentations, together with editorial comments. The editorial policy is to encourage frank discussion. On this basis contributions are invited.

INDUSTRIAL HYGIENE

The Editorial Committee will exercise its best judgment in selecting for publication the material which presents most exactly the factors affecting industrial health and developments for control of potentially injurious exposures. The editors may not concur in opinions expressed by the authors but will endeavor to assure authenticity of fact.

The Science, the Law and the Economics of Industrial Health

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Dust Concentrations in Stone Crushing Operations

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THE SILICOSIS hazard in the stone crushing industry is significant because of the frequent occurrence of high exposures to silica bearing rock dust. The New York State stone crushing code, Bulletin 34, limits the allowable dust concentration to 10 m.p.p.c.f. in dust from stone formations having over 10% free silica, and to 100 m.p.p.c.f, when the free silica content is less than 10%. A study of the rock from 218 quarries in the state in 1939 and 1940 showed that 60% of the quarries had rock with a free silica content of less than 10%. Among the quarries and mines for which dust counts are reported in this paper, 64% have rock with free silica content of less than 10%. In all cases, however, there must be an appreciable free silica content to the rock to justify its inclusion under the provisions of the above noted code.

This code also requires that "not less than three (3) dust samples of at least 10 minutes duration, spaced at intervals to yield a fair average measurement of exposure over the entire cycle of operations, shall be collected in the normal breathing zone on the premises by a standard type impinger or other equivalent sampling instrument. The atmospheric dust concentration shall be deemed to be the average concentration as determined from the samples by the use of the light field, low power technic count or its equivalent."

The engineers of the Division of Industrial Hygiene have been called upon to determine the dust concentrations in all stone crushing plants in New York State for the purpose of enforcing this code. The good judgment of these engineers has been relied upon to see that the samples were so spaced and taken at such locations as to truly measure the dust exposure of the worker.

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(Table of Contents on page 3.)

Dust Sampling Technique

IT IS frequently impossible to break down the worker's dust exposure into that produced by the different machines or equipment in a plant especially when the units of equipment are adjacent to one another or in the same room. Thus a chute discharging into a crusher, which in turn discharges into a bucket elevator, will produce dust in the chute, in the crusher, at the crusher discharge, and in the elevator. A worker whose duties are to operate the crusher is exposed to dust from all these sources. An air sample taken in his normal breathing zone will show his exposure, but usually cannot be broken down to show what percentage of the total dust concentration results from the operation of each piece of equipment. In a situation such as this the three samples can be taken at any time during the shift, and, although actually a room condition will be shown rather than a machine condition, it will still show the man exposure, which, as pointed out, is what we seek.

In cases where the workers' duties require them to attend several machines or points in one room or space, the three samples can be taken following the worker from point to point in order to evaluate his dust exposure.

Entirely different conditions prevail in cases where the worker remains in a fixed location, but, because of variabilities of wind or material flow, or both, a true evaluation of his dust exposure cannot be made with three samples at a single point. Thus in the case of an operator attending a primary crusher located practically in the open, his dust exposure will vary depending upon the direction and velocity of the wind. Under such conditions three samples gathered in one location in the breathing zone of the operator may show average results either higher or lower than the true exposure depending upon whether the worker is upwind or downwind of the machine. In such cases an attempt is made to determine average exposure by taking the three samples in different directions

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from the machine, upwind, downwind and crosswind, all samples being taken at the breathing zone in that location. These samples may show wide variation from each other, but the average count will be a truer indication of the worker's exposure than any of the individual counts.

In cases of discontinuous flow of material, the normal flow must first be analyzed to determine the sampling technic. Thus if it takes five minutes to empty a truck into a primary crusher and three minutes for the truck to be removed and the next truck brought up, the sample would be taken for 10 continuous minutes, although dust would be generated for only seven of the 10 minutes. If the sampling had been discontinued for the three minutes of no dust production, the counts would be too high from a viewpoint of average exposure of the man required to remain at the crusher head. However if it took five minutes to empty a truck and 15 minutes for the truck to be removed and the next truck brought into position, a five-minute sample would be taken because the operator is not required to remain at this location.

Stone Crushing Operations

STONE is crushed either to yield crushed stone as a commercial product or to size the stone for subsequent pulverization. Plants which pulverize most or all of the plant throughput include cement, talc and gypsum mills, ore sintering, flotation, tabling and electrostatic concentration plants, and agricultural limestone plants. Operations and equipment similar to those used in stone crushing and pulverizing are also used to crush and pulverize artificial stone-like materials such as blast furnace slag, cement clinker, ceramics, and synthetic abrasives. Dust counts made in plants handling this latter group of materials are not included in this paper.

The most numerous of stone crushing plants are sand and gravel plants, in the operation of which it is customary to pass the entire plant run over a primary bar grizzly or screen with the oversize on the screen passing through a primary crusher. Because this crusher is usually outdoors, casually attended, and handling a fairly uniform, smooth-surfaced, moist feed, man exposure to dust at this operation is very low. Since subsequent screening also is invariably wet, outdoors and unattended, as is the discharge of the washed and screened product to the storage bins, low dust exposures result from these operations, too. Some few gravel plants recrush some of the screened product to make sharp-edged stone out of some of the round screened product. It is only at recrushers, operated dry, and attended by a worker to maintain a uniform flow of stone from the storage bin to the crusher that man exposures in excess of 10 m.p.p.c.f. have been found. Generally speaking, no samples for dust counts are taken at sand and gravel plants except when visual evidence indicates an unusual condition such as that just noted.

Crushed Stone Plants

THE second largest group of stone crushing plants comprises those associated with surface quarries which produce crushed stone for road building, concrete aggregate and railroad ballast. This type of plant varies widely in the extent of enclosure of dust producing equipment ranging from those having no walls (i.e., the equipment supported by an open structural frame) and requiring no attendance during operation, hence no man exposure; to those having all equipment inside building walls and requiring constant attendance by workers during operation. Of the plants which are totally enclosed operations, there is an important group which operates with no one inside the building except for occasional inspection and where oiling and maintenance are carried on only when the entire plant is shut down. Dust concentrations inside this type of building can rise to very high levels but man exposure is low so long as these operating procedures are rigidly practiced. Counts were not taken inside such structures whenever we were convinced of the fact that no work was done inside the dusty structure and to this extent our reported counts represented man-exposure average lower than counts representing actual dust production in stone crushing operations. In those plants where men worked inside the structure, man exposure and dust production were the same.

The majority of the commercial crushed stone plants, which operate dry, consist of a primary crusher, a screen house, secondary crushers and storage bins together with the necessary conveyors or elevators to move the stone from operation to operation. A very few plants have a washing plant to clean the crushed stone and, incidentally, make the subsequent handling of the stone much less dusty. These latter must not be confused with the use of spray heads for dust abatement which requires much less water and does not dedust the stone itself. Plants which operate dry and without dust control tend to produce dust at all operations with the resulting man exposure being proportional to the extent of exclosure, wind velocity at the time of sampling and the condition of the operating equipment. Dust control either in the form of

TABLE I.
DISTRIBUTION OF 45 TRIPLICATE SETS OF DUST COUNTS IN CRUSHED STONE PLANTS (135 INDIVIDUAL COUNTS) BY DUST COUNT RANGE AND OPERATION

Range of Counts Mppcf	Number of Individual Counts						Number of Triplicate Averages					
	Crushing	Screening	Bins	(a) Bagging	(b) Misc.	Total	Crushing	Screening	Bins	(a) Bagging	(b) Misc.	Total
0 - 100	11	4	6	3	6	30	3	1	2	1	2	9
100 - 200	8	17	—	3	—	28	4	6	—	1	—	11
200 - 300	12	7	—	2	—	21	1	2	—	—	—	3
300 - 400	9	3	—	—	—	12	5	1	—	—	—	6
400 - 500	5	5	—	—	—	10	3	2	—	1	—	6
500 - 600	3	4	—	—	—	7	—	1	—	—	—	1
600 - 700	2	1	—	—	—	3	—	1	—	—	—	1
700 - 800	3	1	1	1	—	6	2	—	—	—	—	2
800 - 900	2	1	—	—	—	3	1	—	—	—	—	1
900 - 1000	2	—	1	—	—	3	—	1	—	—	—	1
1000 - 1100	—	3	—	—	—	3	—	—	1	—	—	1
1100 - 1200	—	1	—	—	—	1	—	—	—	—	—	—
1200 - 1300	—	4	—	—	—	4	—	2	—	—	—	2
1300 - 1400	—	2	1	—	—	3	—	1	—	—	—	1
Over 1400	—	1	—	—	—	1	—	—	—	—	—	—
Total	57	54	9	9	6	135	19	18	3	3	2	45

(a) Bagging Pulverized limestone. (b) Belt Walkway & Apron Feeder.

TABLE II.
DISTRIBUTION OF 16 TRIPLICATE SETS OF DUST COUNTS IN TALC MILLS (48 INDIVIDUAL COUNTS) BY DUST COUNT RANGE AND OPERATION

Range of Counts Mppcf	Number of Individual Counts						Number of Triplicate Averages					
	Crushing	Screening	Mill	Bagging	(a) Misc.	Total	Crushing	Screening	Mill	Bagging	(a) Misc.	Total
0 - 100	2	2	6	3	—	13	1	1	2	1	—	5
100 - 200	3	1	5	3	—	12	1	—	—	1	—	2
200 - 300	1	—	3	2	—	6	—	—	3	1	—	4
300 - 400	—	1	—	3	—	4	—	—	—	—	—	—
400 - 500	2	—	1	—	2	5	1	—	—	1	—	2
500 - 600	1	—	1	1	—	3	—	1	—	—	1	2
600 - 700	—	2	2	—	—	4	—	—	1	—	—	1
700 - 800	—	—	—	—	1	1	—	—	—	—	—	—
Total	9	6	18	12	3	48	3	2	6	4	1	16

(a) Top of Garner.

sprays or ventilation will obviously decrease this exposure in direct proportion to its effectiveness. This study has been confined to dust counts in plants without effective dust control and purports to show the man exposures in those plants without adequate methods of dust control.

Dust Counts in Crushed Stone Plants

DURING the past two years, we have taken 45 sets of triplicate samples at 20 such plants, and, although our work in this field in other similar plants is still continuing, we have prepared the accompanying analysis (Table I) of results to date. This analysis shows that in both crusher building and screen house about half the counts obtained were in excess of 300 m.p.p.c.f. and that less than 10% of screen house counts and 20% of crusher building counts were under 100 m.p.p.c.f. With one exception, all counts of over 1000 m.p.p.c.f. were found in screen houses. Counts taken in other than crushing or screening areas were generally below 300 m.p.p.c.f. The extreme range of counts in this industry is noteworthy and reflects considerations of plant design and operation already discussed.

Milling Operations—Talc

THE THIRD major group of stone crushing plants are associated with mines which pulverize all or most of the plant throughput. In New York State the metal mining plants, crushing and pulverizing iron, zinc, and titanium ores are as a rule well equipped with dust control equipment. The same holds true for cement and gypsum plants. The principal mining and milling industry in the state which is carried on without dust control is talc milling. Sixteen sets of triplicate dust counts (Table II) were taken recently in five talc mills. All but one of these counts were below 700 m.p.p.c.f.); about half being above 200 m.p.p.c.f. and half below. In this industry the highest counts are associated with milling and bagging rather than crushing and screening, because the talc industry uses auger-type bagging machines rather than the less dusty valve bag machine filling reported in Table I for several agricultural limestone bagging operations.

An interesting side light on the counts taken in talc mills are the series of extremely high counts shown in Table III. These counts have not been included in Table II even though the first two represent in-plant exposures. The latter two are effluent concentrations of interest because of the extent that they show contamination of the atmosphere exterior to the mill and so add to man exposure in the mill work areas because of re-entrance.

TABLE III.
SOME UNUSUALLY HIGH DUST COUNTS IN STONE CRUSHING PLANTS

Operation or Location	Rock	Counts 1	2	3
Discharge of crushed rock from elevator to car	Talc	1330	2220	2520
Adjacent to cloth wall of dust blow room	Talc	2160	2160	2460
Adjacent to blow room vent on roof	Talc	1122	1475	3280
Adjacent to blow room vent on roof	Talc	2960	4840	7450

Variability of Dust Counts

THE 61 sets of triplicate counts in both crushed stone plants (Table I) and talc mills (Table II) offer an opportunity to investigate the variability of counts and the significance of individual and average counts in these industries. We therefore computed for each set of triplicate counts, the maximum deviation of one of the three counts from the average of the three, and also the percentage this maximum deviation is of that average. As an example, the average of the three counts 250, 300, 320 is 290; the three deviations of individual counts from average are 40, 10, and 30 respectively; maximum deviation, 40 is 13.8% of the average, 290, so that the % maximum deviation is 13.8%. Table IV shows the range of % maximum deviations for low, medium and high dust counts, and Table V shows, for each of these dust count groups, the per cent of counts having % maxium deviations less than 30, 50, and 70% respectively[m]. These tables illustrate the tendency of counts below 100 m.p.p.c.f. to show high percentage deviation and of higher counts to show lower percentage deviation In so far as counts are usually taken to establish whether or not counts

TABLE IV.
MAXIMUM PERCENT DEVIATION OF A SINGLE COUNT FROM AVERAGE, AMONG 61 TRIPLICATE SETS OF DUST COUNTS

Max. % Deviation From Average	Number of Counts: Counts between 0 - 100 m.p.p.c.f.	Counts between 100 - 300 m.p.p.c.f.	Counts over 300 m.p.p.c.f.	All Counts
0 - 10	—	4	3	7
10 - 20	1	3	11	15
20 - 30	1	4	8	13
30 - 40	1	4	1	6
40 - 50	2	—	1	3
50 - 60	1	4	1	6
60 - 70	3	1	1	5
70 - 80	3	—	—	3
80 - 90	2	—	1	3
Total	14	20	27	61

TABLE V.
PERCENT OF TRIPLICATE SETS OF DUST COUNTS HAVING MAXIMUM PERCENT DEVIATION FROM AVERAGE OF LESS THAN 30, 50 AND 70%, RESPECTIVELY

% Max. Deviation	% Dust Counts: Counts between 0 - 100 m.p.p.c.f.	Counts between 100 - 300 m.p.p.c.f.	Counts over 300 m.p.p.c.f.	All Counts
30%	14	55	82	57
50%	36	75	89	71
70%	64	100	96	90

are within maximum allowable concentration, and since the maximum allowable concentrations stipulated in almost all dust control codes are within the 0-100 m.p.p.c.f. range, this study points up the necessity for taking triplicate counts to achieve accuracy when the dust level is below 100 m.p.p.c.f., and the waste of effort in so doing when the level is over 300 m.p.p.c.f. In the latter case, one count is sufficient to establish the fact that counts are in excess of 100 m.p.p.c.f. When counts are between 100 and 300 m.p.p.c.f., duplicate counts are sufficient to confirm the fact that counts are in this intermediate range.

Toxicity of Some of the Newer Plastics

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A FULL discussion of this subject would be a difficult assignment in view of the recent great increase both in number of available plastics and applications for them. I will, therefore, attempt to cover only some of the more generally used newer plastics and the newer applications for some of the older ones. At this time no effort will be made to cover some of the materials which might be included under the general head of plastics, such as the synthetic rubbers, some of the compounds made from natural rubber, vulcanized fibre materials, cold molded bituminous and ceramic materials, natural gum and resin products, and some of the newer synthetic plastics which as yet have relatively limited and specialized uses.

The angle from which the discussion of toxicity will have the most value must be considered. The actual manufacture of the plastics themselves seldom presents serious hazards from toxicity, even though some of the materials used are of course definitely toxic. This is because the hazards are usually well understood and controlled by the primary manufacturer. Here, as in the case of many chemical products, there is considerable difference in hazard between the production of a basic material and in its varied uses in the manufacture of finished products. Many plastics as they reach the consumer are plasticized or may have various materials added as modifying agents, fillers, etc., and not infrequently hazards to the user come from these sources rather than from any properties of the resin itself.

As just mentioned, there are many toxic materials used in the production of the basic resins. The first commercially important synthetic resins were those made by combining phenol and formaldehyde—both toxic—though when these are completely reacted the resulting resin is quite inert. Then urea combined with formaldehyde was used, and currently melamine is also used in the same way. Vinyl chloride and vinyl acetate, sytrene, ethylene and methyl methacrylate, and many other materials have been found useful in producing synthetic resins. In spite of the toxic properties of some of these materials it is remarkable how little difficulty from this source has been experienced in making the basic resins. Production is largely in enclosed systems, and under normal operating conditions workers are but little exposed.

Very few cases of systemic poisoning have occurred, and relatively few cases of local reactions, in spite of the enormous tonnage of production.

A rather different situation exists in industry's utilization of the plastics. Here they are handled under a great variety of conditions and in many forms. To make them applicable for their many uses they are commonly combined with other substances. These include such items as fillers, colors, lubricants, plasticizers, stabilizers, hardeners, solvents. Many of these introduce toxic hazards, especially when the manufacturing process calls for the use of heat. Aside from the use of solvents, with the inherent hazard of possible systemic poisoning from inhaling excessive concentrations of vapors, the outstanding source of trouble in the use of plastics is local, i.e., dermatitis. Finished products made from plastics are seldom, if ever, directly irritant, and only in a few instances and under unusual conditions do they cause sensitization with resulting dermatitis. There are many stages in the handling of plastics, especially when mixed with various modifying agents, when, if full precautions are not taken, contact with the material, or in some instances exposure to vapors, may produce irritation or sensitization and dermatitis will result.

The following summarizes the major types of plastic, indicating some of the toxic hazards which may be present. This list does not include all the plastic materials now used but does include the older ones with reference to their increased use in new applications.

Phenol-Formaldehyde Resins: Thermo-setting resin. Heat usually applied to complete reaction. This liberates some formaldehyde vapor. Repeated exposure to this vapor may cause sensitization and ultimately dermatitis in some exposed. Ample ventilation should be provided, and in case of drying ovens local exhaust ventilation is often required.

Molding compounds: Continued contact with skin, especially moist skin may cause irritation.

Coating materials, varnishes, etc.: Resin not completely reacted, so may be free phenol or formaldehyde present. Solvents added, usually alcohols or hydrocarbons. Continued skin contact may produce dermatitis. When applied as spray, mist must be controlled, and good ventilation provided for drying ovens if used.

Adhesives—for laminated material, bristle setting, etc.: Resin not completely reacted. Hardeners may be added. Continued skin contact may produce dermatitis.

Fillers—many used with these resins. No special hazard.

Phenol-Furfural: Thermo-setting resin. Properties generally similar to those of above, but without hazards due to formaldehyde. May be source of irritation if unreacted furfural or phenol is present.

Urea-formaldehyde: Melamine-formaldehyde: Thermo-setting resins with general properties resembling those of urea-formaldehyde. Same hazards from irritation and sensitization to formaldehyde present, but practically none from urea.

Vinyl chloride and copolymers: Vinyl chloride-vinyl acetate: Thermoplastic resins. Used with and without plasticizers. Rigid unplasticized material free from any essential toxic hazards. Flexible, plasticized material, sometimes of complex formulations, in certain applications and under certain conditions may present hazards due to contained plasticizers, etc., which see.

Vinylidene chloride—copolymer with vinyl chloride: Thermoplastic. Like vinyl chloride and chloride-acetate resins. Unplasticized resin. Essentially inert physiologically.

Polyvinyl butyral: Thermoplastic, usually used highly plasticized, but in its present applications has no toxic hazards.

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Polyvinyl acetate: Usually used involving addition of solvents which would determine possible toxic effects.

Polyethylene: Thermoplastic flexible material generally used unplasticized. Essentially inert physiologically.

Polystyrene: Thermoplastic, rigid material used unplasticized. Essentially inert physiologically.

Methyl methacrylate resin: Thermoplastic, rigid material, unplasticized. Essentially inert physiologically.

AS MENTIONED earlier, the toxicity hazard in the use of plastics is not due in any appreciable degree to the resins themselves but is generally due to the various added materials. These may be grouped under the following heads: fillers; colors; lubricants; hardeners; antioxidants; stabilizers; plasticizers; solvents.

Fillers: These are usually such materials as wood flour, walnut shell flour, paper, cotton as fibre or fabric, asbestos, diatomaceous silica, and lately glass fibre, usually as fabric. These are added to molding compounds, and in the form of paper or fabric are used to build up laminated plastic products. Their use does not involve any toxic hazard. Some reports have alleged that the use of fibre glass fabric increases the hazard from dermatitis, though this does not seem to have been verified. Careless handling of the dry fabric might produce a minor degree of irritation generally of a transient nature. Once incorporated in the resin it should cause no trouble, and dermatitis noted here would be more likely due to contact with unreacted resin components.

Colors: These are usually present in very small amounts, and are of the same type as used in inks, textiles, etc., and few, if any, would present any hazard through use in plastics.

Lubricants: These are oily materials, such as mineral or castor oil preparations, added in small amount to resin formulations to aid in molding, calendering, etc.

Hardeners: These are materials added in small quantities to some formulations, such as adhesives and sometimes coating materials, to aid in setting. The one probably most frequently used is hexamethylenetetramine—the "hexa" of the rubber industry. This is a well recognized sensitizing agent, and when used particular care should be taken to avoid unnecessary or continuous skin contact or dermatitis is very apt to follow.

Antioxidants and stabilizers: These are materials added to many plastic formulations to help control adverse effects of exposure to light, heat, etc. They include a number of organometallic compounds, some of which in concentrated form are primary skin irritants, and toxic internally. In plastics, however, they are present only in small amounts and so incorporated in the plastic as to produce toxic effects only under unusual conditions if at all.

Plasticizers: This large group of materials—there are over 150 now in use—plays a most important part in the use of plastics. They are added to lower brittleness or give flexibility. They are sometimes used singly but often two or more added to a single formulation. To meet certain requirements they may be added in considerable proportion, so that up to 50% of some of the more flexible plastics may consist of plasticizer. One of the difficulties which is involved in their use is their tendency to "sweat out." The loss of plasticizer is influenced by several factors such as temperature, thickness of section, action of moisture and solvents, etc. One noteworthy peculiarity is that some plasticizers which, added alone, tend to rapid loss, when combined with others lose this tendency. This probably accounts for the fact that certain plasticizers which alone act as skin irritants cause very little trouble in a plastic formulation.

The plasticizer content of plastics is of toxicological interest for two reasons. In some formulations the plasticizer may cause dermatitis, and in other cases there would be some possibility that it could be extracted by continued contact with some food products, in sufficient quantity to contaminate the food. Dermatatis would seldom be due to any primary irritation, but would only result from long continued or repeated contact causing sensitization in a small per cent of individuals who were susceptible.

The following lists the principal groups of substances from which come useful plasticizers, and only a few of the most generally used will be mentioned individually:

Natural gums. Camphor. One of the first materials used for this purpose. Still used to considerable extent with nitrocellulose.

Glycol derivatives—e.g., triethylene glycol ethyl butyrate and triethylene glycol ethyl hexoate.

Glycolic acid derivatives—e.g., methyl phthalyl ethyl glycolate; ethyl phthalyl ethyl glycolate; butyl phthalyl butyl glycolate.

Phthalic acid derivatives—e.g.: dimethyl phthalate; diethyl phthalate; dipropyl phthalate; dibutyl phthalate; diamyl phthalate; dicapryl phthalate; dioctyl phthalate; dimethoxyethyl phthalate; diethoxyethyl phthalate; dibutoxyethyl phthalate.

Phosphoric acid derivatives—e.eg., tricresyl phosphate.

Ricinoleic acid derivatives—e.g., butyl acetyl ricinoleate.

Sebacic acid derivatives—e.g., dibutyl sebacate.

Solvents: These have had a very important place in the development and use of plastics. Over 250 have been used in this connection at one time or another. As actually handled in industry the hazard from solvent use is not general with plastics. Aside from plastic preparations for surface coating and some of the adhesives they seldom occur in the plastics as used. Several are used in connection with manufacture of articles from plastic materials, these are usually esters, ethers and ketones. The following list gives some idea of the number and type of solvents which have been used in the plastic field: alcohols—30; amides and amines—50; esters—40; ethers—20; furans—4; glycols—10; halogenated compounds—25; hydrocarbons —30; ketones—12; nitriles, nitrohydrocarbons and sulphur derivatives—6.

Preventive Measures

AS SUGGESTED above, the hazards from toxicity in the use of plastics are relatively slight as far as systemic effects are concerned. The common hazard is that of local injury—dermatitis. This may be a true contact dermatitis, or more commonly will be seen in more susceptible individuals as a result of sensitization from repeated contacts, either directly with some of the plastic compounds, or from vapor exposure. The answer is avoidance of undue exposure to vapors, or excessive skin contact. Good ventilation is required. With most operations good general ventilation is sufficient, but in the case of hot molds, rolls and drying ovens it is often necessary to use hoods and local exhaust ventilation to remove vapors at their source. There are some mixing operations involving dust from dry materials where local exhaust ventilation is indicated. This is especially true with a few of the plastic molding compounds where lead is incorporated.

To control the hazard from dermatitis in the case of resins known to cause such trouble, all unnecessary direct contact with the skin should be avoided. There should be good housekeeping with working areas and equipment frequently cleaned. Personal cleanliness should be insisted upon and ample provision made for frequent washing. Clothing should be clean and frequently changed. Where indicated and applicable, protective clothing should be used such as gloves and aprons. Where a certain amount of skin contact is unavoidable some protection may be obtained by the use of protective creams, though these should not be depended upon as a substitute for personal cleanliness. In the handling of adhesives which are difficult to remove from the skin the material may be removed by swabbing with denatured alcohol. This should always be followed by thorough washing with water and a good soap. Soaps containing a mineral abrasive or use of solvents other than alcohol are not recommended.

In some cases of dermatitis relief may be obtained and the worker can continue on the job if better protection is possible. Some cases of dermatitis will also be found among workers where the materials handled have nothing to do with cause. In a few cases there will be recurrence with every exposure, and such susceptible workers should be transferred to other work. Any case of dermatitis should be referred to a physician, and no medical treatment given except as prescribed by him.

Summary

A DISCUSSION of toxicity of plastics generally does not concern the basic synthetic resins. These are usually inert or at least have a physiological reaction of very low order. Such toxicity as is present is due to the other materials compounded with the resins.

Only a few materials—chiefly solvents—used with synthetic resins are of a type which could under usual conditions of use produce systemic effects. The real problem with plastic compounds is contact dermatitis. With the majority of plastic compounds this is a delayed reaction—a sensitization—rather than what would commonly be understood as a direct irritant action. With most compounds the reaction occurs in a relatively few susceptible individuals.

Contact dermatitis in those handling plastics usually follows direct and repeated or continuous contact with the resin formulation, but may in some cases be due to vapor exposure as in the case of formaldehyde. It occurs relatively with more frequency in the handling of thermosetting resins.

Control depends on control of contact. This means:

Good housekeeping, including good ventilation, general and local.

Personal cleanliness, including avoidance of unnecessary contact.

Frequent washing and use of clean clothing.

Protective clothing and protective skin creams are indicated in some instances. These are only aids to personal cleanliness, however, not substitutes for it.

Radium Dial Painting Control Methods

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THE ENTRANCE of the United States into the war was the cause of an enormous increase in radium dial painting. The demands of the war production program devoted to aircraft and shipbuilding placed such a burden on this particular industry that the mounting orders could not be met. In consequence, the screen method of applying radium paint to dials came into increased prominence. This method eliminated the laborious hand painting by brush, and a worker daily could exceed the weekly output of several workers engaged in the hand painting of the dials. Therefore, the introduction of this method successfully overcame that production lag.

The variety of uses to which radium paint can be applied are numerous. With the probability of having the hazards of this industry as a major peace time problem, the control measures for the application, use and distrbution of radium paint should be broadened and modernized. This paper is concerned primarily with the measures that were taken to control the hazards which arose in the application of the screen method of radium dial painting.

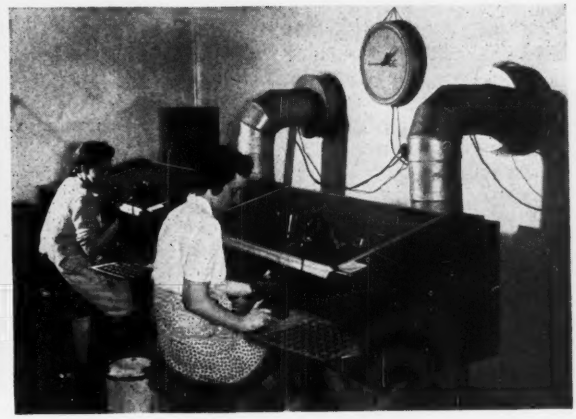
An establishment engaged in this process began operating in the summer of 1942. At the time, conditions in the plant were satisfactory. Four months after the plant had commenced operations, the results of analysis of breath samples of the employees showed the startling fact that they exceeded the accepted tolerance limit for radon by as much as 500%. This tolerance value has been set by the National Bureau of Standards at 10^{-12} curie of radon per liter of expired breath (this corresponds to 0.1 microgram of deposited radium). A re-check confirmed these values. Moreover, a sample of the air in the workroom revealed that it contained close to 200% of the accepted tolerance value established for the radon concentration in the workroom.

This plant immediately ceased operations and an intensive investigation was made by the Bureau of Industrial Hygiene with the fullest cooperation of the management, to determine the extent and cause of this alarming condition. Initially, it was thought that the employees had accidentally ingested large amounts of the radium paint. However, this idea was discarded in the light of future findings. Ventilation measurements in the hoods used for painting in the drying chamber, and in the room in general, showed that the air movement was sufficient in exhaust the normal amount of radon gas that might arise from the process.

However, it was found that the mixing of the radium paint was done on a flat table, located beneath a large wall type exhaust fan. Ventilation measurements on this table showed a great turbulence in the air movement across the table. An inspection of the room with ultra-violet light revealed large areas of luminescent material on the walls and floor. Ordinarily, in radium dial painting work, the ultra-violet light may reveal a few specks of material on the floor at the end of a day's work, but not an extensive contamination of the whole room.

These two findings were sufficient to indict the mixing operation as the main cause of the disturbance. The very fine particles of paint had been dispersed into the atmosphere of the room by the turbulent air motion, had settled on the walls and floor, and had been inhaled by the workers. As a result of these findings the room was thoroughly cleaned with a vacuum cleaner and washed with soap and water and solvent to remove all traces of luminescent material. After an inspection of the shop with ultra-violet light revealed no more contamination, a rearrangement of the processes was begun. The control measures instituted in this shop were extended as increased production demanded expansion of the plant.

Radium Paint Mixing Room
Showing Ventilated Hood



Radium Dial Painting Hoods

The floors were constructed of magnesite which presented a hard, smooth surface containing no cracks. All sharp edges were rounded so that cleaning would be facilitated and accumulation of dust kept to a minimum. The walls and ceiling were made of plaster covered with white enamel paint. The edges were rounded, thus presenting a smooth, even surface. No windows were placed in the rooms. This insured a means of checking the room with an ultra-violet light at all times of the day. All unnecessary ledges, shelves and equipment were removed. The mixing operation was transferred to a separate room built for that purpose and equipped with a hood, similar to those used for dial painting, in which the mixing was done.

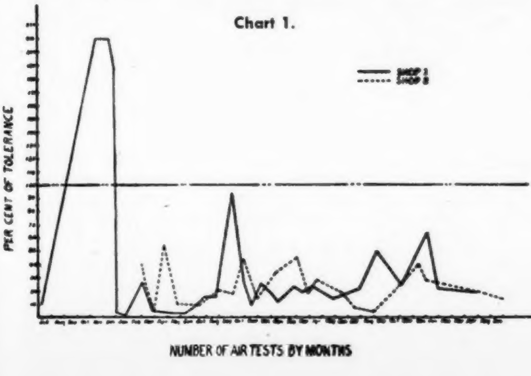
The dial-painting hoods were constructed on the plan proposed by the National Bureau of Standards in its handbook H 27, but were much larger owing to the bulk of the apparatus used for the screen painting. A light fixture was installed inside the hood, in order that the necessary amount of light could be focused upon the work without subjecting the operator to glare from the glass top. On the outside of the hood, an ultra-violet light was placed to furnish the operator with a means of inspecting the dials and also to enable her in inspect her hands regularly for traces of radium compound. These lights were operated by means of foot pedals and left the operator's hands free to perform her work and not permitting them to touch any object outside the booth and contaminate it. The table of the hood was constructed of linoleum from which the wax finish had been removed, leaving a hard, smooth surface, impervious to moisture and solvent. Containers were built into the bottom of the hood so that all waste rags and paper could be dropped into the containers through a slot in the table.

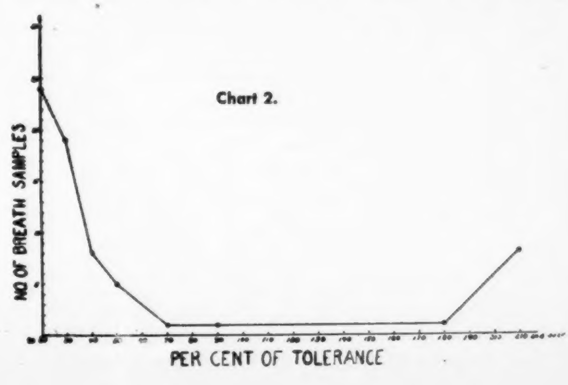
Originally, the exhaust fans had been fixed to the back of the hoods; therefore, dust and radon gas, exhausted from the hoods, had been disseminated into the shop atmosphere through leaks in the duct-work. The fans were re-located, being placed in the wall of the room, obviating any leakage into the room because of the negative pressure existing in the duct. A minimum velocity of 100 fpm is maintained at the face of the hoods. This is sufficient not only to take care of dust and radon gas in the hoods, but also to provide general ventilation for the room. Inlets were placed throughout the room to insure an adequate supply of fresh air.

The drying and storage of the painted dials is done in a chamber outside of the shop. The chamber is reached through a sliding door. Before an employee can move the door to remove or put in the trays of dials, he must turn on an exhaust fan in the chamber. Thus, when the door is opened, there is an inward movement of air into the drying chamber which prevents any radon gas from escaping into the room.

A darkroom was built to enable the operators to inspect their hands and clothes before leaving the room. This room is equipped with an ultra-violet light for self inspection, and hot and cold running water, soap and solvent for cleaning purposes. Brushes are used to scrub the hands and nails in order to remove traces of radium compound which might stubbornly adhere to the skin. The ultra-violet light is operated by means of a foot pedal.

The dial painting room is inspected daily with an ultra-violet light provided for that purpose, and any particles of compound are removed. The plant management takes samples in the room during working hours at frequent intervals in order to keep a close check upon the radon concentration, which is used as an index of proper functioning of the control measures.





Each new employee is given a thorough medical examination before employment. Preliminary training in dial painting technique is given to the new workers, using fluorescent paint. Any indication of carelessness or untidiness marks an individual as unfitted for that work. All employees are instructed in the dangers involved in radium painting. Blood counts are taken on all individuals so that they may serve for comparison with future blood counts in case of excessive radium absorption. The breath samples, however, are mainly relied upon to indicate any radium absorption in the employees. These samples are taken on all employees approximately every six months.

The results of these control measures can be seen from Chart 1. It shows the radon concentrations in the air samples which were taken in the dial painting shop over a period of three years. It can be seen that, since the control program was begun, no sample has shown a radon content exceeding the accepted tolerance limit (10^{-11} curie of radon per liter of air); 90% of all the samples taken have shown radon concentrations below the tolerance value. In shop No. 2, no sample exceeded this value.

Chart 2 shows the results of the breath samples taken on the employees. After control measures were installed no worker exceeded the tolerance value; 61% of all tests were 30% of tolerance or under.

Occasionally, high concentrations of radon gas will be found in both the room samples and in the expired air samples. These concentrations are due to operational procedures associated with the process and to the carelessness of the workers. The latter factor is almost impossible to overcome. However, with strict supervision and proper protective measures, it can be seen that the hazards associated with the screen method of applying radium paint can be minimized.

Report of New Jersey Bureau of Industrial Health

—July 1, 1944: June 30, 1945—

W. G. HAZARD,
Acting Chief

THE fiscal year ending June 30, 1945 was marked by a continued advance in industrial health, both as regards the program of this Bureau and non-official activities in the state generally.

Of the total amount budgeted for Bureau activities, approximately $46,250, 94%, or $43,250, came from state funds, the remainder being Federal grants-in-aid. This does not include the salaries of three Federal employes who were lent to the Bureau. The number of employes under State Civil Service was raised from five to seven.

Through increased personnel and through establishment of a specially equipped industrial hygiene laboratory valuable assistance was rendered to industry.

Coverage of Industry

THE following table shows the type of industry served.

Of the 232 different plants visited, 165, or 71%, employed 500 workers or less. This figure shows that the Bureau filled a real need, for it has been frequently demonstrated that the smaller plants, rather than the larger ones, require more assistance from outside agencies in industrial hygiene activities.

Of the 293 visits made by staff members to plants, 157, or 54%, were requested and 46% self-initiated. This was an increase in requests over last year when 48% of the plant visits were requested. The figure for 1942-1943 was only 25%. The steady increase in proportion of plant visits made as a result of such direct requests is healthy, for it shows that the consultation services of the Bureau are in increasing demand. Since the Bureau has no regulatory powers, it must "sell" its services on their own merits.

Services offered by the Bureau were of two general types: (1) environmental engineering (assistance with plant ventilation, lighting, control of dusts, fumes, gases, and the like), and (2) medical and nursing consultation for the improvement of plant health activities. During the 262 projects handled, 216 environmental engineering services were given (57% of the total services), and 164 medical-nursing services were given (43% of the total services). Because of scarcity of nursing personnel occasioned by the war, the two vacancies for nurses in the Bureau existed through the fiscal year. Many promotional activities in industrial nursing were still carried on, however, mostly by staff physicians.

In addition to classifying services according to their professional character (engineering and medical), they may be examined according to their objectives—whether they were surveys of all departments of a plant from the standpoint of health hazards, or whether they were to handle specific problems, or whether they were follow-up visits on recommendations made earlier. During the 232 plant visits, 97 surveys were conducted, 146 special problems were handled, and 45 follow-up discussions were held.

Of the 232 different plants visited, 101, or 44%, had never been visited before by the Bureau. The remainder, amounting to 132 plants, or 54%, had received Bureau services during prior fiscal years. Thus the Bureau aided many plants that were already familiar with its services, but at the same time acquainted a large number of other plants with our program for the first time this year.

After consultation is given by the Bureau representative during his visit to a plant, a confirming report is mailed which contains specific recommendations where needed. During the year some 437 such recommendations were written.

The Bureau worked closely with the War Production Board, War Manpower Commission, the Army and Navy, and other official Federal and state agencies on health problems connected with war production. Included in Table 1 are special wartime projects for the benefit of New Jersey plants in these industries: (1) foundry and forge, (2) lead refining, and (3) explosives and munitions.

Special Projects

IN ADDITION to plant visits, surveys, consultation and recommendations mentioned above, each year brings new special projects of a non-routine and non-recurring nature. These are described in the following:

FOOD PROCESSING INDUSTRIES:

Food processing and related agricultural industries employ a considerable number of workers who are exposed to certain occupational hazards, such as

TABLE 1—SERVICES TO INDUSTRIAL PLANTS

Industry group	No. of plants visited	No. of employees in plants	No. of projects handled	No. of visits by staff
ALL INDUSTRY GROUPS	232	256797	262	293
Chemical and allied products	55	43358	65	73
Food and kindred products	25	9587	29	31
Iron and steel except machinery	23	24063	25	25
Nonferrous metals and their products	17	9721	18	18
Textile mill products and fibre	17	6661	17	18
Stone, clay and glass products	16	7322	17	22
Electrical machinery	13	63767	21	24
Machinery (except electrical)	12	9609	14	14
Transportation equipment	10	59604	11	12
Paper, printing and allied industries	10	2135	10	11
Apparel and other finished textiles	8	7681	8	11
Lumber and timber basic products	6	983	6	6
Rubber products	6	6867	7	7
Products of petroleum and oil	4	2193	4	4
Miscellaneous industries	10	3746	10	17

dermatitis-producing agents, extremes of temperatures and humidity, and others. For the first time the Bureau made a special study of these during the summer of 1944. Since some of the food processing industries have control over the living conditions of their workers, and since the living conditions influence absenteeism and illness, attention was necessarily directed to these environmental conditions. The study, however, was not one primarily of health conditions among migrant workers as such. It was continued in the spring of 1945 when patch tests were made on food processors exposed to certain vegetable juices to learn their potentialities as dermatitis-producing agents. During the summer of 1944 professional personnel was loaned at night to venereal disease clinics conducted by the Department for migrant farm workers.

X-RAY EXPOSURES FROM ELECTRONIC APPARATUS:

Secondary x-ray exposures caused by high voltage electronic tubes were studied in all plants of the state known to be using these devices. Protective procedures were outlined.

PHYSICAL EXAMINATION DEMONSTRATION:

At the request of a labor union a demonstration was jointly sponsored by the Bureau of Venereal Disease Control, a county tuberculosis association and this Bureau, with the approval of the County Medical Society. A group of union members were given a chest x-ray, a blood test for syphilis and a screening heart examination, all for the purpose of health improvement. Individuals were referred to their family physicians for diagnosis and correction of defects. The demonstration was enthusiastically received.

LABORATORY:

The industrial hygiene laboratory of the Bureau was equipped during the year with specialized apparatus for determining the toxicity of industrial materials. Some 227 samples were analyzed. In addition some 194 determinations were made in the field by direct-reading instruments.

FRANGIBLE BULLET STUDY:

A special study was made in plants manufacturing a new wartime product—frangible lead-plastic bullets. The study consisted of air samples for lead dust and physical examinations to detect excessive lead absorption. Results were handled in such a manner that both management and the workers profited — with discrimination shown towards neither.

COMMUNITY INDUSTRIAL HYGIENE DEMONSTRATION:

With the assistance of a local health officer, one community was selected for an industrial hygiene demonstration. Every plant in the town was visited (project is still in progress) for the purpose of developing technics for bringing industrial health services to the small factories. These are the ones which usually cannot afford their own industrial hygienists, and at the same time they are not familiar with what official services are available to them for the asking.

CENSUS OF INDUSTRIAL NURSES:

Although approximations of the number of nurses in industry have

TABLE 2—CENSUS OF INDUSTRIAL NURSES, 1945

	Number	Percent
TOTAL PERSONS REPORTED BY PLANTS	977	100.0
Classified according to professional qualifications	*832*	*85.2*
Graduate nurses	779	79.8
Registered in New Jersey	597	61.2
Registered, but not in New Jersey	157	16.1
Not registered in any State	25	2.5
Non-graduates performing plant nursing duties	53	5.4
Not classified (qualifications could not be determined)	*145*	*14.8*

TABLE 3—NEW JERSEY PLANT MEDICAL PERSONNEL, 1945

Size group	Number		Percent		Plant medical personnel				
					No. plants with doctor			Percent with	
	Plants	Employees	Plants	Employees	Full-time	Part-time	On call or none	Full- or part-time	On call or none
ALL SIZE GROUPS	1238	693,812	100.0	100.0	46	128	1064	14.0	86.0
1 - 100 employees	396	20,602	32.0	3.0	0	2	394	.5	99.5
101 - 250 employees	405	66,740	32.8	9.6	2	20	383	5.4	94.6
251 - 500 employees	195	71,223	15.7	10.3	2	27	166	14.9	85.1
501 - 1000 employees	118	83,081	9.5	12.0	6	33	79	33.0	67.0
1001 - 5000 employees	98	210,008	7.9	30.2	21	40	37	62.3	37.7
5000 and over	20	242,158	1.6	34.9	15	5	0	100.0	0
Size not given	6	....	.5	....	0	1	5	20.0	80.0

TABLE 4—PLANT NURSING PERSONNEL, 1945

Size group	Total No. plants	FULL-TIME NURSING service								No. with PART-TIME nursing service	No. with NO nursing service
				No. plants with specified no. nurses apiece							
		Total	(Percent)	1 nurse	2 nurses	3 nurses	4 nurses	5 nurses	6 or more		
ALL SIZE GROUPS	1238	349	(28.2)	195	61	24	22	15	32	15	874
1 - 100 employees	396	4	(1.0)	3	1	—	—	—	—	0	392
101 - 250 employees	405	46	(11.4)	43	3	—	—	—	—	6	353
251 - 500 employees	195	96	(49.2)	80	16	—	—	—	—	6	93
501 - 1000 employees	118	95	(80.5)	55	25	10	5	—	—	2	21
1001 - 5000 employees	98	86	(87.8)	14	13	14	16	15	14	1	11
5000 and over	20	20	(100.0)	—	1	—	1	—	17	0	0
Size not given	6	2	(33.3)	—	—	—	—	—	—	0	4

TABLE 5—PLANT DISPENSARY FACILITIES AND PHYSICAL EXAMINATION POLICY

	Total No. plants	PLANT DISPENSARY FACILITIES							No. plants giving PHYS. EXAMINATIONS				
		No. plants with specified no. of dispensary rooms						No. plants with NO dispensary facilities	ALL employees		SOME employees	NONE	
		Total	(Percent)	1 room	2 rooms	3 rooms	4 or more		No. plants	(Percent)		No. plants	(Percent)
ALL SIZE GROUPS	1238	805	(65.0)	545	108	57	95	433	440	(35.6)	148	650	(52.5)
1 - 100 employees	396	156	(39.4)	147	6	3	—	240	60	(15.2)	48	288	(72.7)
101 - 250 employees	405	257	(63.5)	231	19	5	2	148	108	(26.7)	51	246	(60.7)
251 - 500 employees	195	174	(89.3)	112	35	17	10	21	97	(49.7)	28	70	(35.9)
501 - 1000 employees	118	107	(90.6)	44	33	15	15	11	76	(64.4)	12	30	(25.4)
1001 - 5000 employees	98	90	(91.8)	10	14	15	51	8	79	(80.7)	8	11	(11.2)
5000 and over	20	19	(95.0)	—	1	1	17	1	19	(95.0)	1	0	0
Size not given	6	2	(33.3)	1	—	1	—	4	1	(16.7)	0	5	(83.3)

been made from time to time, no accurate census has ever been available to the Bureau. Such a census of industrial nurses was therefore attempted during the year. It was completed before any number of war contracts was cancelled, and so it probably represents the extent of industrial nursing at its wartime peak. Since this figure may not be duplicated for years to come, the census was particularly timely. Results are summarized in Table 2.

EXTENT OF PLANT HEALTH SERVICES: The first comprehensive study of plant health facilities and services was made by the Bureau in the spring of 1945. As in the case of the census of nurses, this study was of more than usual interest. Contract terminations had not arrived when the data were accumulated, and consequently the figures represented a high point in wartime development of plant health programs.

The survey was conducted by letter and by personal interview. Efforts were made to reach 1452 plants. These included practically all plants of over 100 employes, and a group of plants with 100 or less, selected because it was felt the character of their operations might involve an industrial health hazard. Examples of the latter group were those plants that had a potential dust, fume or gas hazard, exposures to dermatitis, toxic materials, or the like. Information was received on 1317 plants, or 90.7% of the total of 1452. Of the 1317 replies, 1238, or 85.3% of the total, could be tabulated. The balance of 79 could not be tabulated because the company was out of business, or for some other reason. Tables 3, 4 and 5 summarize the data collected from 1238 plants.

The total number of employes covered in this study, 693,812, is estimated to represent about 82% of all workers in manufacturing industries of the state at the time. Most of those persons not included were in plants employing 100 or less workers. For plants larger than 100 employes, coverage was high. The survey indicates that the larger plants, say those with more than 500 workers, had more extensive medical, nursing and health facilities than the smaller ones. It emphasizes the importance of stimulating interest in plant health activities in the smaller plants. Even the larger plants reported some need for development. For example, of the plants employing 1001 to 5000 persons, more than a third had medical service which is considered inadequate (no full-time or part-time physician), and one out of every five plants in this size range did not give physical examinations to all new employes —although such a program when administered without prejudice is generally considered mutually beneficial to both worker and employer. One important reason for these deficiencies was unavailability of properly trained doctors and nurses, a lack occasioned by wartime manpower shortages.

General

SEVERAL promotional activities were undertaken to acquaint industry with latest advances in industrial health and with the activities of the Bureau generally. A mailing list was established covering plants, safety engineers, industrial physicians and nurses, and others. An industrial health bulletin was released to these groups periodically. Eleven talks were delivered, two exhibits were displayed, and several articles were published. Two courses in industrial hygiene engineering were conducted in cooperation with Rutgers University.

Six nuisance complaints referred by local health authorities were handled. These included one that involved a large installation of equipment to recover sulfur dioxide, and in getting approval of the equipment from government agencies the Bureau was of assistance.

Preliminary arrangements were made at several dozen plants for x-ray surveys later completed by the Bureau of Tuberculosis Control. The programs of other Bureaus were promoted at every opportunity.

Preventive Methods

—For the Prevention of Industrial Dermatoses—

LOUIS SCHWARTZ, M.D.,
Medical Director, U. S. Public Health Service,
Bethesda, Maryland

THE speed-up of industry in our war program has increased the incidence of industrial dermatoses. The increase is especially marked among workers in the manufacture of tanks, planes, motors, guns, small arms, explosives, and ammunition.

The normal frequency of occupational skin diseases compared to all other skin diseases is about two to one. We have found this ratio to be much higher in the industrial hygiene survey of our war industries which the U. S. Public Health Service is now making. We have come across plants where 100 or more cases of occupational dermatitis were reported to us, and not one of any other occupational disease. This may be explained by the fact that it takes much longer for systemic symptoms of chronic occupational poisoning to manifest themselves than it takes for occupational dermatitis, and also by the fact that our war industries have not been operating a sufficient length of time for chronic occupational poisoning to occur. New factories in which our war materials are made have been especially equipped with modern safety devices designed to protect the workers from the inhalation of poisonous dusts and fumes, thus preventing the occurrence of as many cases of occupational poisonings as have occurred in factories less modernly equipped.

There has not been as much attention paid to the prevention of occupational dermatitis as to the prevention of occupational poisonings, despite the fact that there is more time lost from work on account of occupational dermatitis than from any other occupational disease. It seems as if safety engineers think that the prevention of a mere "occupational itch" is not worth very much thought or bother, but often an "itch" is the first indication of the presence in the air of a systemic poison in toxic quantities. If a chemical irritates the skin, it may also affect the entire system. Protecting the skin may save the whole body.

Presented at the Five-State Regional Governmental Industrial Hygiene Conference, Philadelphia, September 25-26, 1945.

Unlike the protective measures taken against systemic occupational diseases which are practically the same for nearly all—namely, reduction of the concentration of the poison in the air by enclosed processes and exhaust systems—the same method of prevention will not suffice for all of the various skin irritants encountered in our industries. There are many protective measures against the sources of industrial skin irritants.

Pre-Employment Examinations

THE protective measures should begin in the pre-employment examination, in which the skin of the applicant should be carefully examined, and the pathologic conditions found should be noted on the examination card. Applicants with skin eruptions should not be employed in occupations in which there is a marked skin hazard; for instance, those applicants having allergic eczemas should not be employed where there is a marked skin hazard from such well-known sensitizing chemicals as tetryl, fulminate of mercury, the picrates, TNT, formaldehyde and its compounds, synthetic dye manufacture, and numerous others.

Pre-employment patch testing for the purpose of discovering those workers who are allergic is not advisable because workers are usually not allergic to chemicals with which they have had no previous contact. Therefore, very few allergies, if any, would be discovered by this method. Patch testing workers with sensitizing materials may be the means of sensitizin them. Moreover, workers who may be found by patch tests to be sensitive, and therefore rejected, may have a legal claim against the company for having been given a skin eruption they otherwise would not have had.

Careful note should be made of the sites of acne vulgaris lesions on applicants for work in occupations in which they are to be exposed to such occupational acne producers as the solid chlorohydrocarbons, cutting oils, heavy coal-tar-distillates, crude petroleum and lubricants derived from it.

The presence of active mycotic infections on the feet and other parts of the body should be noted. If the applicants are otherwise employable, the fungus infections should be treated while they are working and the parts affected should be properly protected from the action of occupational irritants. If there are common shower baths in the factory, care should be taken to prevent the spread of fungus infections of the feet. This can be done by providing each worker with wooden-soled bathing slippers, and he should be instructed to wear these when going to the shower bath, while he is under the shower, and when coming from it. It is not sufficient to have antiseptic solutions in troughs into which the works are required to step after they have taken their showers because walking barefooted from the troughs to the lockers allows plenty of opportunity for them to pick up or spread the infection. The workers should also be instructed to dry themselves thoroughly and spread powder between their toes before putting on their stockings. The fungi do not grow in dry media. There are many powders on the market for this purpose and most of them contain some antiseptic, such as oxygen in the form of perborates and peroxides, and other fungicidal chemicals.

Applicants who have dry skins should not be placed at jobs where they must immerse their hands in fluids that defat the skin, such as strong soaps, alkaline solutions, or the volatile solvents.

Ventilation

I WILL not go into details as to the installation of totally enclosed manufacturing processes designed to prevent the workers from coming in contact with irritating chemicals, nor will I dwell upon the general and local ventilating devices and hoods designed to draw irritant dusts and fumes away from the worker. These are the province of the industrial hygiene engineer.

It is sufficient for me to say that efficient ventilating processes are of great value in protecting the workers from industrial skin irritants.

Protective Clothing

PROPERLY designed protective clothing is of great value in the prevention of occupational dermatitis. Closely woven cotton fabrics that are more or less impervious to dust are frequently used to protect workers from such irritant dusts as sodium carbonate, calcium cyanamide, etc. To give efficient protection, such fabrics must be frequently cleaned. Each worker should have at least two sets of work clothes so that he will have a clean set to wear while the other is being laundered. It has been found best to have the management of the plant undertake the laundering of such clothes because the worker himself is often loathe to spend the money. In one plant where such was the practice, it was estimated that it cost the plant about 10 cents per day to furnish clean daily work clothes for each worker.

Impervious materials such as rubber, offer better protection against dusts than do fabrics, and they also give protection against irritant liquids. Rubber gloves, aprons, boots, and sleeves are impervious to water-soluble irritants. Rubber, however, soon deteriorates when exposed to alkalis, petroleum distillates, or the chlorohydrocarbon solvents. For this reason it is rather expensive to use in occupations in which it comes in contact with these chemicals. Synthetic rubbers such as neoprene, buna, thiokol, and ameropol are more resistant to alkalis and oils than is natural rubber, but workers often object to wearing rubber garments. Some state that rubber causes them to perspire excessively, and many of them are allergic to compounds in the rubber. Moreover, rubber, both natural and synthetic, is on the priority list and is difficult, if not impossible, to secure for the purpose of protective clothing.

We have found that some of the synthetic resin films, such as pliofilm, manufactured by the Goodyear Tire & Rubber Company, koroseal, manufactured by the B. F. Goodrich Tire & Rubber Company, and vinylite, manufactured by the Union Carbide & Carbon Company, are impervious not only to dust and fumes but also to strong acids, alkalis, and petroleum distillates. These materials may be made into sleeves, aprons, hoods, and coveralls, and they have even been experimentally made into gloves. They are comparatively cheap, noninflammable, easily cleanable with soap and water, and transparent, so that the worker can see the bare arm or the clothes underneath. This latter property removes the psychologic effect of the wearer's feeling confined. It is true that these substances, like rubber, prevent the circulation of air on parts of the body which they enclose, but this can be prevented by placing vent holes in the upper parts of the sleeves and in the rear of the cover-alls, where such holes are not likely to allow the entrance of irritants. We have found that these films also give good protection against the war gases and are suitable for protecting the general population from their vesicant action. They can be made of such tensile strength that, when worn as sleeves by machine operators, they will tear if caught by cogs before they can draw the arm of the worker into the machinery.

These films are affected by trichlorethylene and carbon tetrachloride and, therefore, are not suitable for protective films against these substances. The polyvinyl alcohols are proof against trichlorethylene and carbon tetrachloride. They are manufactured in the form of gloves and called by the trade name of "resistoflex." The polyvinyl alcohols are affected by water and, therefore, resistoflex gloves should not be exposed to it. They may be cleaned with the volatile solvents.

Cellophane or regenerated cellulose is not yet on the priority list. It can be plasticized with glycerin to form a pliable film capable of being made into protective clothing. Cellophane is not affected by acids or petroleum solvents, and is also good protection against war gases. However, it is made hard and brittle by water and is also inflammable.

These disadvantages may be overcome by treating the cellophane film while it is being manufactured with ammonium sulfamate, which makes it flameproof, and by coating it with a water-soluble resin, which makes it waterproof. Cellulose acetate films are water-insoluble and may make suitable protective clothing.

Leather gloves offer good protection against trauma and irritant or sensitizing solids and dusts. Leather gloves should be made of soft, pliable, washable leather, such as chamois. The seams should be finished and smooth. Coarse seams rub and irritate the skin, causing dermatitis not only by mechanical friction, but by rubbing into the denuded skin the irritant chemical particles which have fallen into the glove at the wrist opening. Gloves for the protection of the hands from irritant chemicals should reach well up the forearms and should be worn under impervious sleeves, fastening at the wrists so as to prevent the entrance of irritant chemicals into the glove. Aprons should reach well up to the neck and below the knees. Aprons are of special value in protecting the body from cutting oils. I again emphasize the fact that in order for protective clothing to be really protective it must be cleaned daily.

Cleanliness

CLEANLINESS is by far the most important single measure for the prevention of industrial dermatoses. By cleanliness, we mean not only cleanliness of the person, but cleanliness of the room, the machines, and the clothes. Floors, walls, and ceilings of rooms in which there are industrial irritants should be wet-cleaned daily. Machines and tools on which industrial irritants deposit should also be cleaned daily. Adequate washing facilities should be provided for workers handling industrial skin irritants. Workers whose clothes become soiled with industrial skin irritants should be compelled to take supervised shower baths after work, before leaving the factory. It may be necessary to have a double set of locker rooms to be sure that workers do not put on dirty clothes before going home. Care must be exercised so that the soaps and other cleansers used by workers to remove dirt, dyes, oils, etc., will not themselves cause dermatitis. Workers who become soiled with oils, greases, and dyes are likely, if left to themselves, to use the most available and most rapid-acting solvent to clean the skin. They do not stop to consider the irritant action of the cleanser. Many cases of dermatitis among workers have been caused by

the cleansers used by workers before going home. Safety engineers should see that the workers use only such cleansers as will not act as skin irritants.

An industrial cleanser for the normal skin should have the following qualities:

1. It should be freely soluble in hard, soft, cold, or hot water.
2. It should remove foreign soil, fats, and oils without harming the skin.
3. It should not contain harsh abrasives or irritant scrubbers.
4. It should be handy to use in cake form, or should flow easily through soap dispensers if in granulated powder or liquid form.
5. It should not deteriorate or become insect-infested.

For those occupations in which excessive scrubbing with such soap is necessary in order to remove dyes or tenacious oil, it may be better to add to such a cleanser a small amount of alkali, such as trisodium phosphate, or an organic solvent, such as naphtha. Whenever such alkali, such as trisodium phosphate, or an organic solvent, such as naphtha. Whenever such alkali-reinforced cleansers are used, it is best to supply the worker with an emollient cream to be rubbed into the skin after washing to replace the fat removed by the strong cleanser.

Workers who have dermatitis, or sensitive or dry defatted skins, should not use the ordinary industrial cleanser previously described. It is better for them to use one of the soapless cleansers, the pH of which is 7 or less. Such a cleanser may consist of a neutral sulfonated castor oil containing 1 to 2% of the synthetic wetting agents.

Protective Ointments

WHILE protective ointments are low on the list of preventive measures, they are often the only available means of protection. In most occupations the face cannot be covered by protective clothing. The work must often be performed with bare hands, gloves being unsuited for the operation. Workers, as a rule, dislike to wear protective clothing but seem to have a particular liking for the use of protective ointments. When a protective ointment is used, the worker invariably washes it off with soap and water immediately after work, and so removes not only the ointment but whatever irritants there are on the skin. This washing after work adds considerably to the value of the protection supposedly given by the ointment.

There is no one formula for a protective ointment that will give efficient protection against all skin irritants. However, all protective ointments should have the following properties:

1. They should be nonirritating and nonsensitizing.
2. They should give actual protection from the irritant.
3. They should be of such consistency that they can be easily applied.
4. They should be easily removable after work and yet stay on while the worker is exposed to the irritant.

Protective ointments may be divided into six classes:

1. The simple vanishing-cream type, which fills the pores with soap and facilitates the removal of soil when washing after work.

2. The type which leaves a thin film of a resin or wax on the skin and thus prevents the irritant from touching the skin. This class may be subdivided into (a) water-soluble films, and (b) water-insoluble films. They may be in the form of ointments, emulsions, or solutions. This class of protectives is sometimes called the "invisible glove" type. The water-soluble film is supposed to protect against the volatile solvents and water-insoluble allergens such as TNT and tetryl. The water-insoluble resins and waxes are used to protect against water-soluble irritants. Shellac, benzoin, and nitrocellulose are the most frequently used resins in this form of protective, whereas the water-soluble resins used in protecting against water-insoluble allergens are methyl cellulose, Irish moss, sodium silicate, tragacanth, acacia, and casein.

3. Protective ointments which cover the skin and fill the pores with a harmless fat to repel water-soluble irritants and prevent entrance into the pores of harmful petroleum used as protectives against cutting oils, greases, creosote, pitch, etc. They consist mainly of lanolin and sufficient castor oil to make the lanolin spreadable. The addition of a small amount of a wetting agent makes them easily removable with water, and a small amount of perfume masks the disagreeable odor of lanolin and castor oil.

4. Protective ointments which contain a nonirritant chemical intended to detoxify the industrial irritant. For instance, such a protective cream against acids may contain soap and magnesium hydroxide intended to neutralize the acid.

5. Protective ointments which cause inert powders to adhere to the skin, forming a protective covering against skin irritants. The powders may be calamine, zinc oxide, iron oxide, kieselguhr, Bentonite, etc. The adhesive or binder may be any one of the resins mentioned in the "invisible glove" type of cream. These ointments are of value in protecting against allergenic substances.

6. Protective applications against photo-sensitizing substances, which contain such physical light screens as menthyl salicylate, aesculin, quinine, anthranilates, and tannates.

Most of the protective creams, emulsions, and lotions on the market are combinations of these six types of protective ointments.

The protective measures I have outlined comprise what we now know about the prevention of industrial dermatoses. They leave much to be desired.

If more industrial hygiene engineers and more dermatologists would devote time to this matter, more efficient protective methods would be developed.

References

SCHWARTZ, LOUIS, WARREN, LEON H., and GOLDMAN, FREDERICK H.: Pub. Health Rep. 55: 1158 (June 28) 1940.

SCHWARTZ, LOUIS: Protective Ointments and Industrial Cleansers. To be published in the July issue of Saunder's Medical and Surgical Clinics of North America.

American Industrial Hygiene Association

News of Local Sections

Chicago Section

ON DECEMBER 19, 1945, DR. PAUL BAMBERGER, Medical Department, Bethlehem Steel Corporation, presented "Experience in the use of Aluminum Compounds in the Treatment of Silicosis," and M. I. DORFAN, Chief Dust Collector Engineer, American Foundry Equipment Company discussed "Design and Control Factors in Dust Control Engineering."

At the meeting held January 16, 1946, DR. PAUL A. BREHM, Supervisor, Industrial Hygiene Unit, State Board of Health, Madison, Wisconsin, addressed the Chicago Section on "Industrial Hygiene Experiences Under Post War Problems," and Senior Sanitary Engineer (R) Harry F. Seifert, Chief of Engineering Unit, Industrial Hygiene Division, U. S. Public Health Service, Washintgon, D. C., presented "Engineering Control of Some of the Recent Important Exposures."

Georgia Section

ON DECEMBER 7, 1945, DR. LOUIS SCHWARTZ, Chief of the Dermatoses Section, U. S. Public Health Service, presented an outstanding discussion covering occupational diseases of the skin. The material presented to the group served to answer many questions on the cause of industrial skin diseases.

Michigan Society

ON DECEMBER 20, 1945, a dinner meeting was held at the Wardell-Sheraton Hotel, Detroit, Michigan. FRANK PATTY, Industrial Hygiene Consultant, DAVID MOULD, Safety Director and DR. C. D. SELBY, Medical Consultant, of General Motors Corporation, discussed "Coordination of Industrial Hygiene, Safety Engineering and Industrial Medicine."

Pittsburgh Section

THE Pittsburgh Section of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION met at the U. S. Bureau of Mines on the evening of January 29. The Mine Safety Appliances Company's new sound movie on the development, use and care of respirators entitled "The Air We Breathe" was shown. MR. E. C. BARNES, of Westinghouse Corporation, described a new method developed by the Westinghouse Industrial Hygiene Laboratory for sampling and analyzing chlorinated hydrocarbon gases and vapors. Election of officers for the

coming year was held. Officers for 1946 are:

F. J. PEARCE, U. S. Bureau of Mines—Chairman.

H. W. SPEICHER, Westinghouse Electric Corporation—Vice-Chairman.

C. H. MEHAFFEY, Mine Safety Appliances Company—Secretary-Treasurer.

DR. F. R. HOLDEN, Industrial Hygiene Foundation—Counsellor.

A. M. STANG, Division of Industrial Hygiene, Pennsylvania Department of Health—Counsellor.

Metropolitan New York Section

A DISCUSSION of "Nitro-Amino Compounds of the Aromatic Series" was discussed at the December 6, 1945, meeting by DR. A. F. MANGELSDORFF, Calco Chemical Division of the American Cyanamid Company. His talk is summarized as follows:

"The nitro and amino compounds of the aromatic series are many and varied. They are obtained as by-products from the distillation of coal tar. The simplest ones are nitrobenzene and aniline. The formation of methemoglobin is characteristic of most of these compounds. The addition of other ions or groups changes the toxicity. As example, ortho toluidine gives bladder irirtation with hematuria and frequency. Dinitrochlorbenzene produces skin irritation with typical contact dermatitis. The pharmacology of these compounds was discussed briefly. Chronic aniline poisonin does not exist. The formation of methemoglobin is always the result of contact or inhalation or ingestion of some of the nitro and amino compounds. Each intoxication is an acute poisoning and completely clears up as shown by the use of the recording spectrophotometer. Safety measures and protection measures were discussed, and a number of case histories were presented."

The following officers were elected for the 1946 year:

MERRIL EISENBUD—Chairman.

ARTHUR C. STERN—Chairman-Elect.

WILLIAM R. BRADLEY—Past Chairman.

LEONARD J. GOLDWATER—Councilor.

LEOPOLD SCHEFLAN — Secretary-Treasurer.

The February 7, 1946, meeting is to take the form of a round-table discussion dealing with problems in fabric coating.

St. Louis Section

ON DECEMBER 19, 1945, DR. ROBERT KEHOE, of the Kettering Laboratory of the University of Cincinnati, presented "Safe Versus Hazardous Lead Exposures."

DR. KEHOE had just returned from an Army-sponsored trip to Europe which was made for the purpose of inspecting and studying the industrial hygiene, the industrial toxicology and the industrial safety provisions as carried on chiefly by the Germans during the war.

On January 17, 1946, DR. RAYMOND SUNDERMAN, Medical Director, St. Louis Ordnance Plant, U. S. Cartridge Company, discussed: "The Classification and Pathological Physiology of Industrial Diseases."

Wayne University School of Occupational Health

—Conferences on Industrial Medical Relations—

GENERAL Subject: "Advanced Procedures in Industrial Employment": January 9-April 3, 1946.

January 9: "Recovery and Convalescence as Related to Traumatic Injury"—Speakers: DR. ROBERT ELMAN, Professor of Surgery, Washington University, St. Louis. (During the war DR. ELMAN served as Vice-Chairman, Committee of Convalescence and Rehabilitation, Division of Medical Sciences, National Research Council, and conducted extensive researches in the general field of convalescence.)

MISS MERLE DRAPER, Case Work Supervisor, Medical Social Department, Harper Hospital, Detroit.

January 16: "Occupational Restoration Following Traumatic Injury"—Speaker: DR. H. D. STORMS, Director, Rehabilitation Clinic, Ontario Workman's Compensation Board, Toronto.

January 23: "Evaluation of Occupational Capacity and Ability Following Traumatic Injury" — Positive Health. Speaker: DR. GEORGE DEAVER, Director Division of Physical Medicine, New York University College of Medicine; Medical Director, Institute for the Crippled and Disabled, New York City.

January 30: "Employment of Handicapped Persons" — Speakers: DR. HAROLD VONACHEN, Medical Director, Caterpillar Tractor Company, Peoria, Illinois (who has done outstanding work in the field of rehabilitation of veterans).

MR. HAROLD HAYES, Chief of the Handicapped Placement, U. S. Employment Service, Detroit.

February 6: "Occupational Therapy and Vocational Rehabilitation" — Speaker: MISS MARJORIE FISH, Director of Occupational Therapy, Department of Physical Medicine, Columbia University Medical Center.

February 13: "Selective Job Placement and Job Adjustment"—Positive Health. Speakers: ORLO CRISSEY, PH.D., Educational Director and Industrial Psychologist, A. C. Spark Plug Division, General Motors Corporation.

HARRY BURNHAM, M.A., Associate to MR. CRISSEY.

FRANK WHITEHOUSE, PH.D., Head, Department of Selective Testing, Ford Motor Company.

February 20: To be announced.

February 27: "Developments in the Field of Industrial Safety"—Speaker: DR. WILLIAM P. YANT, Director of Research, Mine Safety Appliance Company, Pittsburgh; Chairman, Committee on Research, National Safety Council.

March 6: "The Relation of Nutrition to Industrial Employment"—Speakers: DR. W. A. SAWYER, Medical Director, Eastman Kodak Company, Rochester.

MRS. Q. A. DODGE, Chairman, Committee on Industrial Nutrition of the Massachusetts State Committee on Industrial Health; Associate Professor, Institute of Management, School of Home Economics, Simmons College, Boston.

March 13: "Relation of Private Practitioner to Employee Health Programs"—Speaker: DR. W. J. FULTON, Baltimore.

March 20: "Special Problems of Women in Industrial Employment"—Speaker: DR. ANNA BAETJER, Assistant Professor, Physiological Hygiene, Johns Hopkins University.

March 27: "Medical Examinations in Relation to Industrial Employment"—Panel: Leader to be DR. HARVEY BARTLE, Chairman, Committee on Medical Examinations, Council on Industrial Health, American Medical Association: recently retired as Medical Director, Pennsylvania Railroad. Other members of the panel to be announced.

April 3: "Administrative Medicine in Industrial Organization"—Panel: Leader to be DR. C. O. SAPPINGTON, Consultant to the Industrial Hygiene Foundation, Mellon Institute, Pittsburgh; Editor of INDUSTRIAL MEDICINE. Other members of the panel to be announced.

Physical Examinations

—Value in Industry—

JUST how valuable this examination of employees before they start work in industry is shown by a comparison of 10 shipyards, five located on the East and Gulf coasts which required an examination and five on the Gulf and West coasts which did not require examination. The examination was fair to employees, and they were classified for grades of work according to their physical condition. CHARLES M. MCGILL, M.D., M.P.H., Portland, Oregon, director, Division Industrial Hygiene, who reports the results of his comparison of both groups of shipyards in the *Journal of the American Medical Association*, gives the following conclusions. The average number of employees in both groups was 100,000. "The average number of hernias and serious injury cases per month, and the rate of these per thousand men monthly are about three times as high in the yards which did not have physical examinations as in the yards which did have physical examinations."

—DR. JAMES W. BARTON, in "Your Health Talk," in *Perth Amboy News*, January 16, 1946.